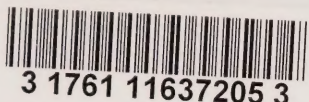


# R ESEARCH HIGHLIGHTS

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## REVIEW OF OHC BUILDING ENERGY AND WATER AUDITS

### Introduction

The Ontario Housing Corporation (OHC) owns approximately 84,000 public housing units which are managed, on OHC's behalf, by 54 local housing authorities. In addition to ensuring that buildings are well maintained and provide a quality living environment, OHC is committed to ensuring that the buildings are efficient in their use of energy and water. To this end, OHC commissioned building energy and water audits on 88 buildings, which represents approximately 10% of their portfolio. Through these audits, OHC expected to evaluate the performance of their buildings in terms of energy and water usage and to identify opportunities to improve the overall efficiency of their buildings.

### Research Program

Eighty-eight buildings in the OHC portfolio were reviewed by five independent consultants. The buildings were randomly selected to represent all regions of the province and all building types. Those selected ranged from one storey to 23 stories, from 10 units to 489 units, and from construction dates of 1960 to 1989. Both senior and family buildings were included in the sample. For each building audited, the consultants were required to examine fuel and water bills dating from at least two years prior to the audit.

The consultants identified potential energy conservation measures (ECMs) for each building that could reduce energy and water consumption. Then they performed engineering calculations and estimated capital costs to determine the financial viability (payback) of each measure. A cursory review of the

results was conducted to ensure consistency between consultants. The consultants did not consider ECMs that would require a change in OHC policy. For example, individual utility billing of tenants has the potential to reduce energy and water usage, but was not considered because it would require a change in how OHC bills tenants. As the sample size was approximately 10% of the portfolio, the consolidated results were grossed up by a factor of 10 to represent the entire OHC portfolio.

For each building, an overall building energy performance index (BEPI) was determined by dividing the building annual energy consumption by the building floor area. Included in the BEPI are energy loads for space heating, domestic water heating, ventilation and lighting. Similarly, a water consumption index (WCI) was established in the same manner as the BEPI. The WCI includes all domestic water loads from showers and toilets, to laundry and landscaping. The use of these indices allows the consumption patterns of different buildings to be compared even when their building characteristics vary significantly. The average BEPI and WCI values for the OHC portfolio were compared to similar buildings in the private sector to assess their relative energy and water usage.

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## Results

The annual energy consumption of the OHC buildings in the study was found to average 232 ekWh/m<sup>2</sup> <sup>(1)</sup>.

Two-thirds of the buildings fall in the range of 150 to 250 ekWh/m<sup>2</sup>. These results were found to be comparable with private sector buildings.

The distribution of BEPI values was examined by occupant type, fuel type, degree-days, year of construction, number of stories, gross floor area, and region. One of the strongest factors affecting BEPI was the age of the building. There was also a general increase in BEPI with height of building and floor area. However, BEPI did not necessarily correspond to degree-days. In fact, there appeared to be an inverse trend in energy use with degree-days—the colder the location, the lower the energy consumption. It is speculated that the reason for this somewhat surprising result is that buildings in northern Ontario compensate for the colder climate by being better insulated than buildings in southern Ontario. Also, the large number of buildings in (relatively warm) Toronto tended to skew the results. Furthermore, it was found that several other factors contributed to buildings in the Toronto region having greater energy usage than buildings in colder locations. These factors included the greater proportion of family-type buildings in Toronto and the presence of larger and taller buildings. Family-type buildings use almost twice the energy as senior-type buildings on a per unit floor area basis, likely due to higher occupant densities.

The average water consumption of the OHC buildings in the study averaged 1.91 m<sup>3</sup>/m<sup>2</sup>/year, with a spread of 0.26 to 3.83 m<sup>3</sup>/m<sup>2</sup>/year. Water consumption values were analyzed for the same factors as the BEPI values. WCI values showed very little dependence on occupant type, degree-days, age, height, floor area or region. The only significant variation was with fuel type, although it was unclear why gas-heated buildings would use more water than electrically-heated buildings. The fact that gas-heated buildings usually use hydronic systems that require make-up water, may leak or lose water during maintenance, may account for the variation.

Energy and water conservation measures (ECMs) identified by the consultants were grouped into 41 distinct ECMs, 36 of which were considered feasible (see Table 1). ECMs in the table are listed in order of decreasing payback. Half of the measures have a payback of less than five years and are low cost and easy to implement with little disruption to building tenants. However, these measures also have the smallest savings. The largest cost savings were found to be those measures dealing with fuel conversion or retrofit of the heating systems.

While the savings for each measure is a reasonable estimate, as a group, the savings are likely slightly overstated; the interaction between measures implemented in the same building would tend to reduce total savings. For example, conversion of the heating fuel from electricity to natural gas will reduce the costs savings from air sealing (based on electricity as the heating fuel). The magnitude of the interaction cannot be generalized, as it will vary on a case by case basis.

There are many advantages and disadvantages of ECMs beyond the economics of the measure. Some measures, such as air sealing and upgrading of the lighting, can have a positive influence on the quality of the living environment. Other measures can increase maintenance requirements, such as conversion from electricity to natural gas heating or the installation of ventilation heat recovery. Finally, some measures can result in a significant disruption to the building common and in-suite spaces, such as conversion of electric baseboard heating to hydronic heating. In selecting the most appropriate ECM for a building, these additional factors also need to be taken into consideration.

The most commonly recommended ECMs, and the percentage of buildings studied in which their application would be feasible, were:

- upgrading the lighting in common areas to T8 fluorescent lighting (68%),
- sealing doors (35%),
- installing aerator faucets (23%),
- installing motion detectors or timers on common lighting (23%),

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<sup>1</sup> To get ekWh/m<sup>2</sup>, gas consumption is converted to equivalent kilowatt-hours, which is combined with electrical consumption data and the result then expressed in equivalent kWh divided by the building area.



**Table 2.1: List of Recommended Energy Conservation Measures (ECM) and Performance in Audited Buildings**

ECM No.	Energy Conservation Measures	% of Stock	Cost per Building (\$)	Annual Savings (\$)	Payback (Years)
1	Install early closure flappers on toilets	5%	795	681	1.4
2	Install aerator faucets	23%	885	1,184	1.6
3	Install low flow shower heads	11%	881	698	1.6
4	Seal stairwell vents	1%	200	100	2.0
5	Upgrade wall insulation	1%	7,000	3,000	2.3
6	Convert water heaters to gas	5%	10,375	5,876	2.3
7	Convert in-suite lighting to fluorescent	7%	2,842	1,248	2.3
8	Outdoor reset controller on common heating	3%	3,000	1,200	2.5
9	Seal windows	11%	2,910	1,131	2.8
10	Variable speed drive water booster pumps	16%	6,643	2,086	3.2
11	Convert common lighting to fluorescent	14%	1,988	563	3.4
12	Seal doors	35%	1,910	543	3.8
13	Motion detectors, timers on parking lighting	1%	3,600	950	3.8
14	CO controls for parking garage exhaust	7%	10,667	2,783	3.9
15	Thermostatic control on standpipe heat trace	2%	2,000	500	4.0
16	Convert exterior flood lighting to HPS	2%	1,525	411	4.1
17	Upgrade roof and attic insulation	6%	2,902	836	4.6
18	Motion detectors, timers on service lighting	3%	3,667	733	5.0
19	Convert make-up air to gas	17%	8,580	1,798	5.3
20	Upgrade common fluorescent lighting to T8	68%	2,911	604	5.4
21	Motion detectors, timers on common lighting	23%	4,158	827	5.5
22	Modify heating piping for better temp control	20%	37,806	7,250	5.7
23	Replace doors	8%	3,371	589	5.9
24	Convert exterior lighting to fluorescent	5%	138	23	5.9
25	Seal air-conditioner sleeves	1%	8,700	1,450	6.0
26	Install radiator controls on tenant heating	20%	36,114	5,838	6.1
27	Convert water heater to indirect system	3%	24,533	4,333	6.8
28	Convert common heating system to gas	14%	266,383	33,474	7.2
29	Night setback control on water heaters	13%	4,255	656	7.2
30	Add heat recovery to exhaust system	19%	89,469	13,116	7.3
31	Install low-flush toilets	14%	11,179	1,913	7.5
32	Convert in-suite heating to gas	8%	132,143	17,486	7.6
33	Install electronic thermostats for suite heating	8%	5,613	649	8.7
34	Upgrade exit signs	5%	525	71	8.0
35	Eliminate parking garage heating	3%	45,333	4,533	10.0
36	Replace windows	3%	23,667	3,300	10.0

- modifying heating system piping to permit lower delivery temperatures (20%), and
- installing radiator controls on in-suite heating systems (20%).

All the measures identified may be more widely applicable than indicated but the consultants found that in many buildings the ECM had already been implemented. Measures identified as requiring further study included the installation of energy management systems, the installation of co-generation systems, and the operation of the make-up air system.

## Implications for the Housing Industry

The potential overall impact of implementing the ECM recommendations in the report is significant. The Building Energy Performance Index (BEPI) could potentially be reduced by 12% and the Water Conservation Index (WCI) by 8%. When extrapolated to the entire OHC portfolio, \$85 M (1998 dollars) of expenditures is recommended with predicted annual savings of \$13.7 M, or a 6.2 year payback. Furthermore, the ECMs have the potential to improve the quality of living of the housing stock.

As the energy usage of the OHC buildings was found to be comparable to private sector buildings, similar results could be expected in private buildings. Clearly, the implementation of energy conservation measures in multi-unit residential buildings represents a significant opportunity to reduce energy and water usage and should be an important component of any plans for housing sustainability or for greenhouse gas reduction.

The report has the added benefit of providing building owners and property managers with statistics on energy and water usage so that they can evaluate the performance of their own buildings.

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## Housing Research at CMHC

Under Part IX of the *National Housing Act*, the Government of Canada provides funds to CMHC to conduct research into the social, economic and technical aspects of housing and related fields, and to undertake the publishing and distribution of the results of this research.

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